

# TAXONOMIC STUDIES OF SOME AUSTRALIAN LEPTODACTYLID FROGS OF THE GENUS *CYCLORANA* STEINDACHNER

by

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## ABSTRACT

TYLER, M. J., and MARTIN, A. A. 1976. Taxonomic studies of some Australian leptodactylid frogs of the genus *Cyclorana* Steindachner. *Rec. S. Aust. Mus.* 17 (15): 261-276.

The Australian leptodactylid frogs *Cyclorana brevipes* and *C. cultripes* are here redefined on the basis of adult morphology and mating calls. Frogs variously reported to be these species from Western Australia, the Northern Territory, Queensland and New South Wales are shown to represent different species. Five new species are described here.

## INTRODUCTION

The leptodactylid frogs of the genus *Cyclorana* Steindachner occur throughout Australia with the exception of the extreme south-eastern and south-western portions of the continent. As defined by Parker (1940) the genus comprises seven species and, although its content has been changed substantially by subsequent workers, the total of species has been maintained. The additions are *C. slevini* Loveridge (1950) from southeast Queensland, and the type species *C. novaehollandiae* Steindachner which was resurrected from the synonymy of *C. australis* (Gray) by Tyler & Martin (1975). The species recognised by Parker but subsequently removed from the genus are *C. inermis* and *C. alboguttatus*, which were shown by Straughan (1969) and Tyler (1974) respectively to be hylid frogs of the genus *Litoria*. Cogger (1975), on seemingly arbitrary grounds, retains *alboguttatus* in *Cyclorana*. However, we continue to regard it as a hylid frog of the genus *Litoria*, a disposition which has now received additional support from chromosomal studies (Morescalchi & Ingram, 1974).

It has been suggested that the genus *Cyclorana* has hylid affinities, and also that Australian hylids and leptodactylids are derived from a common ancestor (Tyler 1970). There are considerable data in support of the first hypothesis: affinities in musculature were demonstrated by Tyler (1972), similarities of proportions of the adrenal catecholamines by Robinson & Tyler (1972) and similarities in larval structure and biology by

Watson & Martin (1973). In addition, N. G. Stephenson (pers. comm.) has found that there are numerous chromosomal similarities between *C. platycephalus* and species of *Litoria*.

In the course of studies of the poorly documented species *C. brevipes* and *C. cultripes* we had difficulty in confirming the identification of preserved specimens in various museum collections. Eventually it became clear that several undescribed species are included under these names. Our purpose here is to define the existing species and describe new ones and thus take a further step towards evaluating the genus.

## MATERIAL AND METHODS

Specimens reported here are deposited in university and museum collections abbreviated as follows:—

A.M. = Australian Museum, Sydney

B.M. = British Museum (Natural History) London

J.C.U. = Department of Biology, James Cook University of North Queensland, Townsville

M.C.Z. = Museum of Comparative Zoology, Harvard University, Boston, U.S.A.

M.U.D.Z. = Department of Zoology, University of Melbourne

N.M.V. = National Museum of Victoria, Melbourne

N.P.W.S. = National Parks and Wildlife Service, Yeerongpilly, Brisbane

N.T.M. = Northern Territory Museum, Alice Springs

Q.M. = Queensland Museum, Brisbane

S.A.M. = South Australian Museum, Adelaide

W.A.M. = Western Australian Museum, Perth

Methods of measurement and of recording and analysis of mating calls follow our previous treatment of members of this genus (Tyler & Martin 1975).

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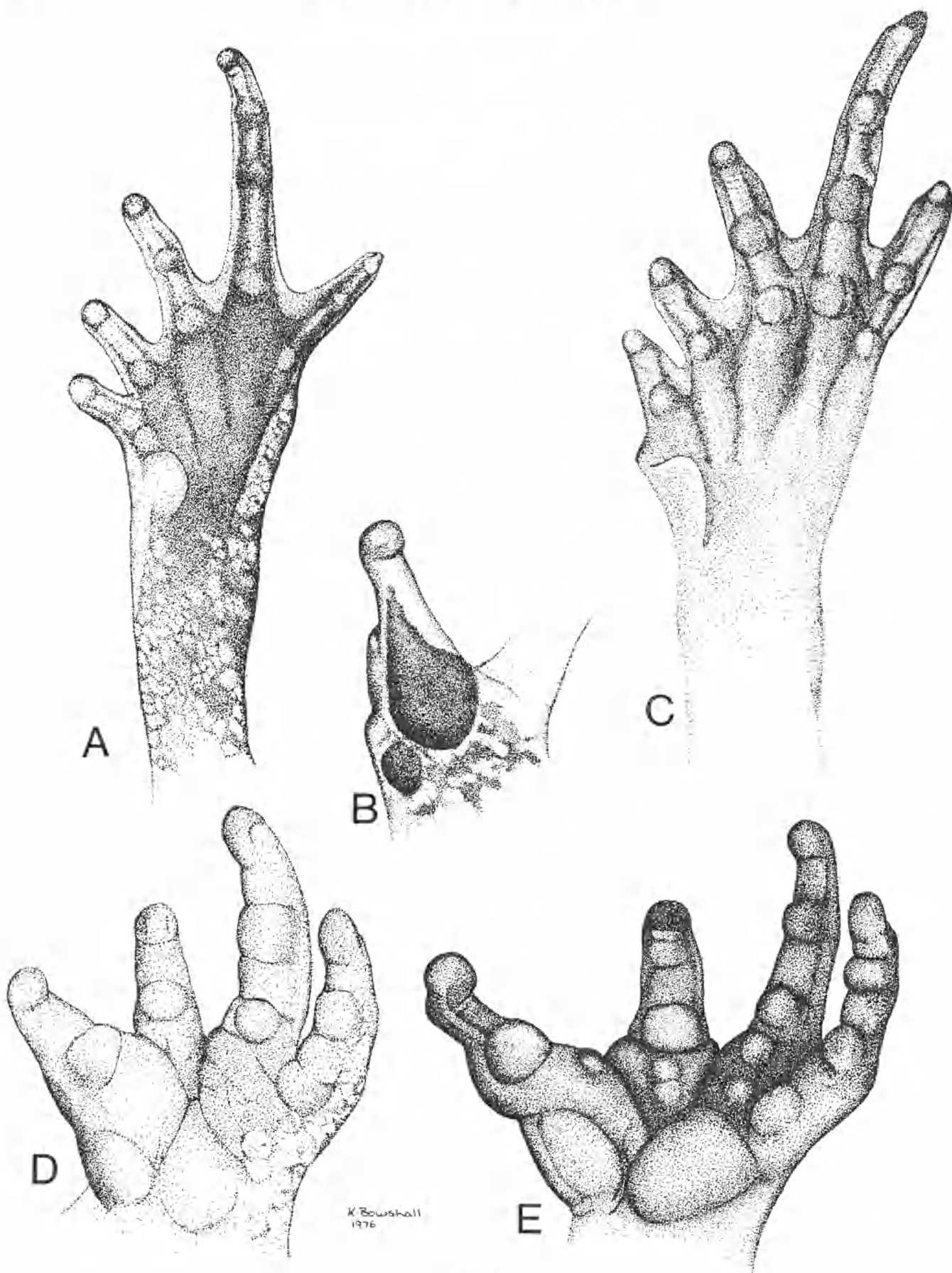


FIG. 1

Hands and feet of *Cyclorana* species: A = Foot of *C. longipes* (WAM R 14157); B = first digit of *C. longipes* showing nuptial pads (WAM R 14157); C = foot of *C. cultripes* (NMV D 12703); D = hand of *C. longipes* (WAM R 14157); E = hand of *C. cultripes* (NMV D 12703).

## SYSTEMATICS

*Cyclorana* Steindachner, 1867

The leptodactylid frogs of the subfamily Cyclorandinae are distinguished morphologically from those of the Myobatrachinae by possession of a broad tongue, and omohyoideus muscle, pedunculate alary processes on the hyoid, and confluent occipital condyles.

*Cyclorana* is distinguished from all other cyclorandine genera by possession of a differentiated intermandibularis muscle, forming an apical element. It is further distinguished from *Notaden* by possession of teeth on the maxilla and premaxilla, and from *Heleioporus*, *Mixophyes* and *Neobatrachus* by having the first finger opposed to the remainder (Fig. 1).

Lynch (1971) has provided a detailed generic diagnosis of *Cyclorana*, and we defer any major redefinition pending completion of our studies of all members of this genus. However, insofar as the species discussed here are concerned, the following data diverge from Lynch (1971), who studied other species:—

**Squamosal:**—The zygomatic process of the squamosal is in extensive juxtaposition with the maxilla (not a feature confined to *australis*).

**Palatine:**—Each palatine bears pronounced pre- and post-choanal alae.

**Tympanum:**—The tympanum is normally visible, but is completely covered with skin in *C. cryptotis*.

Within the genus *Cyclorana* several species groups are recognisable. *C. australis* and *C. novaehollandiae* comprise one group. They are large, robust frogs (S-V range for adults 61.4–120 mm) in which there is exostosis of the maxillary, premaxillary, frontoparietal and squamosal bones (Tyler & Martin 1975). *Cyclorana platycephalus* is similarly a large frog but lacks exostosed skull bones. It has extensive webbing between the toes, and possesses a shovel-shaped inner metatarsal tubercle. *Cyclorana dahli* is a large frog adapted to aquatic conditions. It has fully webbed toes but lacks such a tubercle, and lacks an exostosed skull.

The remaining species are smaller in size, possess two separate nuptial pads on the first finger (Fig. 1), and have little or no webbing between the fingers. These species form the subject of the present paper.

All the species on which we have call data share an essentially similar mating call structure. Following the interpretation of Watkins (1967) of

signals of the kind represented, the basic call structure can be described as a pulse-modulated pure frequency. Interspecific variations occur in frequency, pulse rate and duration of the signal.

To assist in treatment of the undescribed forms the currently recognised species *C. brevipes* (Peters) and *C. cultripes* Parker are first redefined.

*Cyclorana brevipes* (Peters)

*Chiroleptes brevipes* Peters, 1871, Mber. Akad., Berlin 1871: 648

*Chiroleptes brevipalmatus* Gunther, 1876, J. Mus. Godeffroy, 12: 47

*Phractops brevipes*: Nieden, 1923: 523

*Cyclorana brevipes*: Parker, 1940: 21

**Holotype:** A presumably subadult specimen (S-V 31 mm) collected at Bowen ("Port Bowen"), Queensland, by Godeffroy. Specimen now missing (G. Peters *in litt.*).

**Definition:** A small or moderate-sized species (S-V of males 36–45 mm), clearly distinguished from congeners by its smooth skin and striking dorsal pattern of sharply demarcated areas of dark pigment on a very pale greyish or brownish background (Fig. 2).

**Description:** The head is broadly rounded when viewed from above and ranges from being distinctly broader than long to almost as broad as long (HL/HW 0.84–0.98). The snout is rounded when viewed from above and in profile. The eye is conspicuous, its diameter almost one and one-half times the eye to naris distance. The canthus rostralis is straight and inconspicuous. The nostrils are inclined laterally and separated from one another by a distance which is almost invariably greater than the internarial span (E-N/IN 0.97–1.19). The tympanum is entirely visible except for the upper portion of its annulus which is occasionally hidden beneath the supratympanic fold.

The tongue has a diameter of about one-half of the gape of the mouth, and is almost entirely free behind. The choanae are small and widely spaced, and the vomerine teeth are on obliquely converging elevations whose posterior margins reach or extend behind the posterior margins of the choanae.

The fingers are short, unwebbed and without lateral fringes. The foot has a prominent inner metatarsal tubercle. The toes are webbed only at the base, the webbing on the fifth toe not reaching the subarticular tubercle at the base of the penultimate phalanx. The hind limbs are very short (TL/S-V 0.36–0.45).

The skin of the dorsal surface is entirely smooth. The ventral surface is smooth anteriorly and finely granular on the abdomen.

In preservative the dorsal surface is pale grey marked with sharply defined vermiculations of black or dark slate. There is a narrow white vertebral stripe extending posteriorly at least as far as the sacral region. Dark markings are commonly absent from the posterior margin of the head, creating a pale, transverse, broad post-

ocular bar. There is a dark stripe from the tip of the snout to the eye. The posterior surfaces of the thighs are an immaculate dull brown. The ventral surface is usually white or a dull cream colour, with the submandibular margin of adult males varying from pale grey to black.

*Material examined:* Queensland—QM J 18773-74 Ban Ban; JCU A15 (4 specimens), SAM R 3966 (2) Bowen; QM J 18776 14 km E. of Biggenden; AM R 16928 Gin Gin; QM J

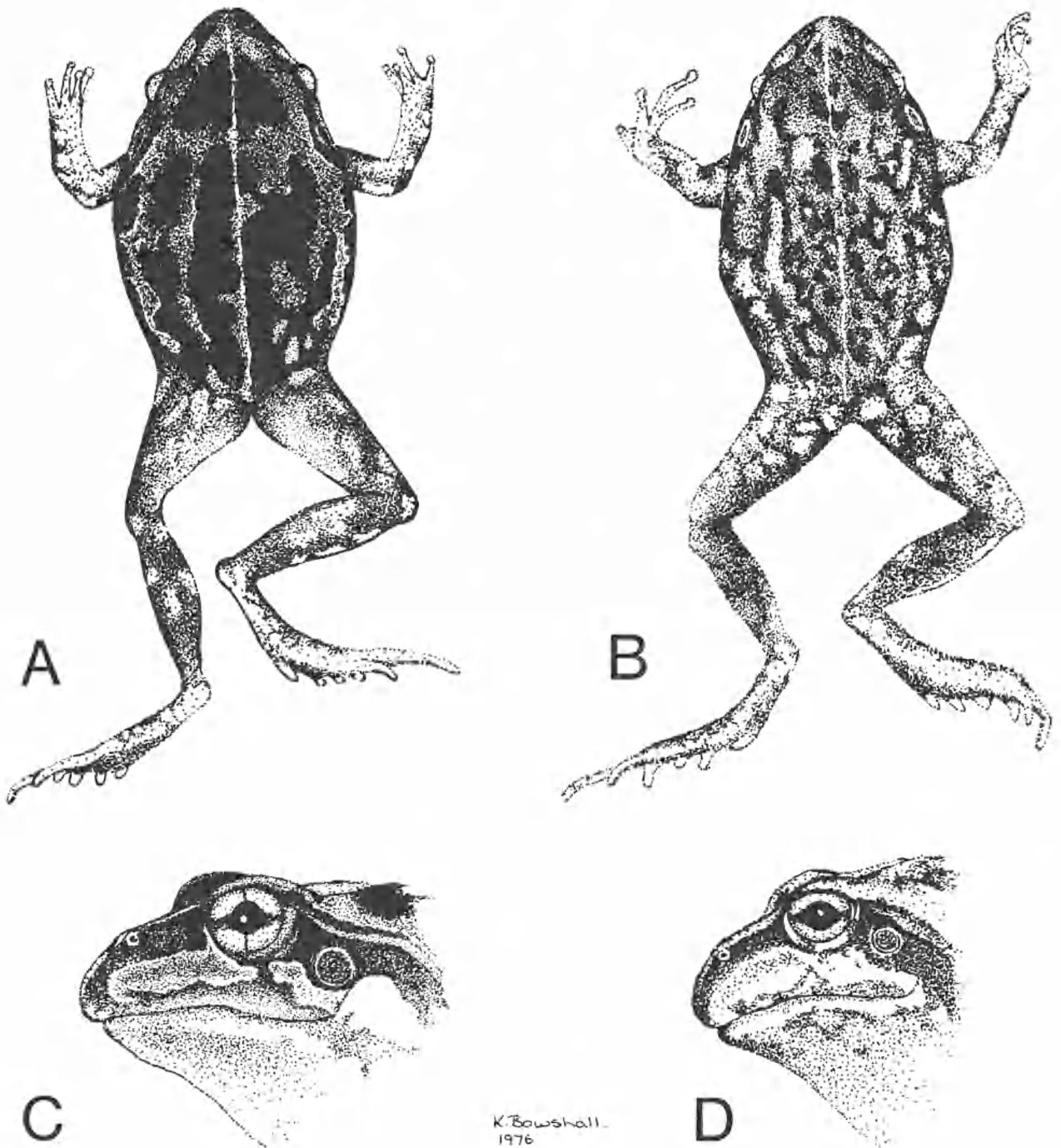


FIG. 2

A and B dorsal and lateral aspects of *Cyclorana brevipes* (SAM R 15223); C and D dorsal and lateral aspects of *C. verrucosus* (QM J 18117).

18775 Helidon; MUDZ 109/70, 110/70 6 km E. of Gracemere; SAM R 15223 Mourangee Station, Edungalba; QM J 18771, 18772, 18777, 18779, 18118, Murphy's Lagoon near Townsville; SAM R 15488 Bundaberg (alizarin); *New South Wales*—QM J 18778 Warrumbungle Natnl. Pk.

**Comparison with other species:** This species can be distinguished from all congeners except *C. longipes* and *C. maculosus* by the existence of very sharply demarcated areas of black or intense brown pigment on the dorsum. Detailed comparisons of these species with *C. brevipes* appear in the accounts of those species. Some other species possess dark markings but in none is there a sharp delimitation from the background colouration.

The existence of the dark markings is sufficient to distinguish the species from *C. cultripes* which (in preservative) is most commonly a dull, dowdy grey frog lacking any dark pattern. In addition *C. cultripes* tends to have shorter legs, the TL/S-V ratio for *C. brevipes* being 0.36-0.45 (mean 0.41) and for *C. cultripes* 0.33-0.40 (mean 0.37).

**Call:** Calls of *C. brevipes* were recorded 6 km E. of Gracemere, Qld., on 19-20.i.1970. The frogs were calling from positions near the margins of a permanent pond in lightly-forested country; wet bulb air temperatures at the calling sites ranged from 23.8°C to 25.8°C. Calls of five individuals were recorded, and mean values (with ranges in parentheses) are: call duration 1090

msec (957-1460); dominant frequency 1930 Hz (1470-2210); pulse repetition rate 169 pulses/sec (163-175) (Fig. 3).

**Discussion:** *Chiroleptes brevipes* Peters was based on a single, unsexed specimen with a "total length" (probably slightly more than snout to vent length) of 31 mm. No illustrations of the species were provided and, in the absence of the holotype and any previous critical studies, it is virtually obligatory for us to investigate its identity.

Boulenger (1882) referred *Chiroleptes brevipalmatus* Gunther to the synonymy of *brevipes*. In the light of the fraction of the Australian species known at that time, such an action also merits investigation. Insofar as the latter step is concerned our material conforms to, and varies from, the elaborate pattern depicted by Boulenger to an extent that eliminates any doubts based solely on external morphology.

Other than in size the only real areas of difference between our material and Peters' description of *brevipes* involve colouration. In particular none of our specimens tallies with the description of the surface of the thighs and of the ventral surface. Peters (1871) writes: "Die Hinterseite der Oberschenkel schwarz. Die ganz Unterseite einfarbig rostbraun". In other species examined by us there is not a difference of this magnitude between immature and adult material, leading us to attribute the darker colour of the holotype

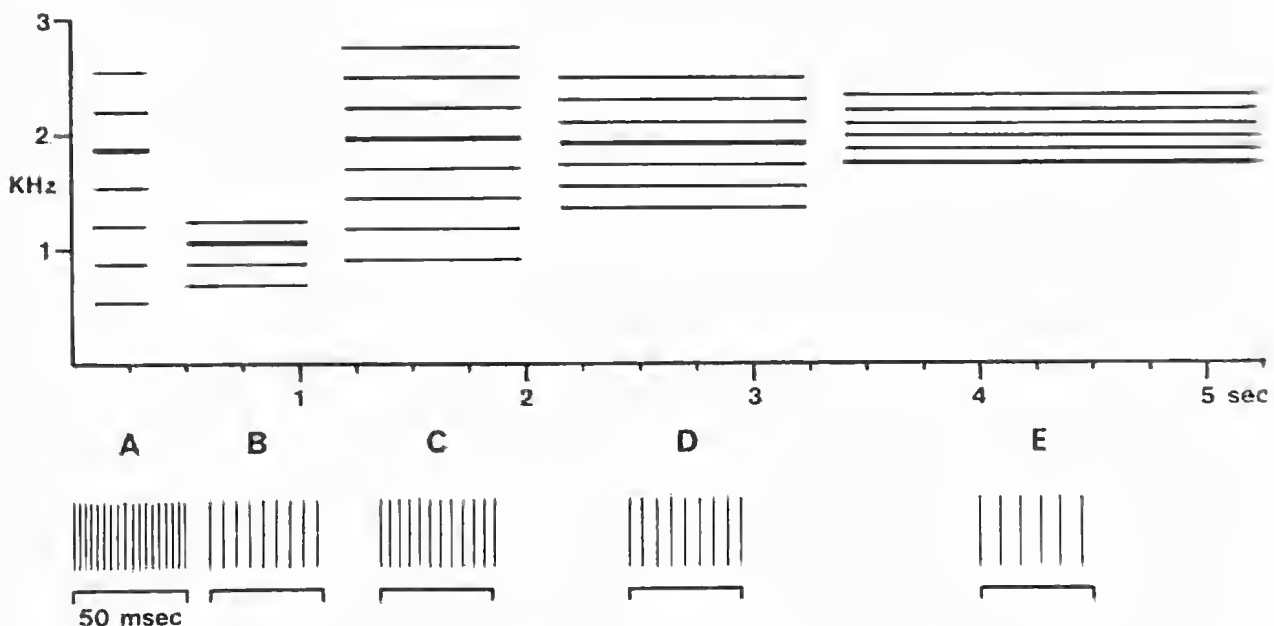


FIG. 3

Diagrams showing male mating call structure of: A, *C. cultripes*; B, *C. cryptotis*; C, *C. maini*; D, *C. brevipes*; E, *C. maculosus*. In each case the upper trace is a representation of an audiospectrogram and the lower trace a diagram of the pulse repetition rate, showing the number of pulses in a 50 msec segment of the call. Details of recording localities are contained in the text.



venter to an artefact of preservation, rather than to an ontogenetic trend.

*Distribution:* In addition to the localities cited above, this species has been taken at Port Denison, Peak Downs and Gayndah (types of *C. brevipalmatus*) and from Coomooboolaroo Station, Qld. (Slevin 1955). As indicated in Fig. 4 the species occurs in coastal Queensland south of latitude 19°, and east of the Great Dividing Range.

A series of four frogs (NMV D0737-40), taken at Lower Archer River on the Cape York Peninsula by J. Thompson in 1933, has been excluded from this species but is not assigned to any other at this stage. Their narrowly spaced nostrils (E-N/IN 1.22-1.25) are conspicuously different from the habitus of all 21 measured specimens throughout the considerable geographic

range of *C. brevipes*. It is conceivable that these frogs represent *longipes* despite the vast gap in distribution between the Lower Archer River and north-eastern Western Australia.

*Cyclorana cultripes* Parker

*Mitrolysis alboguttatus* (non Gunther): Loveridge (1935): 13 (part).

*Cyclorana cultripes* Parker, 1940: 22 (part).

*Holotype:* BM 1908. 2.25.33, an adult male, collected at Alexandra, Northern Territory, by W. Stalker.

*Definition:* A moderate-sized species (males 43-52 mm, females 44-55 mm) with short hind limbs; dorsally marked with a broad, pale, transverse,

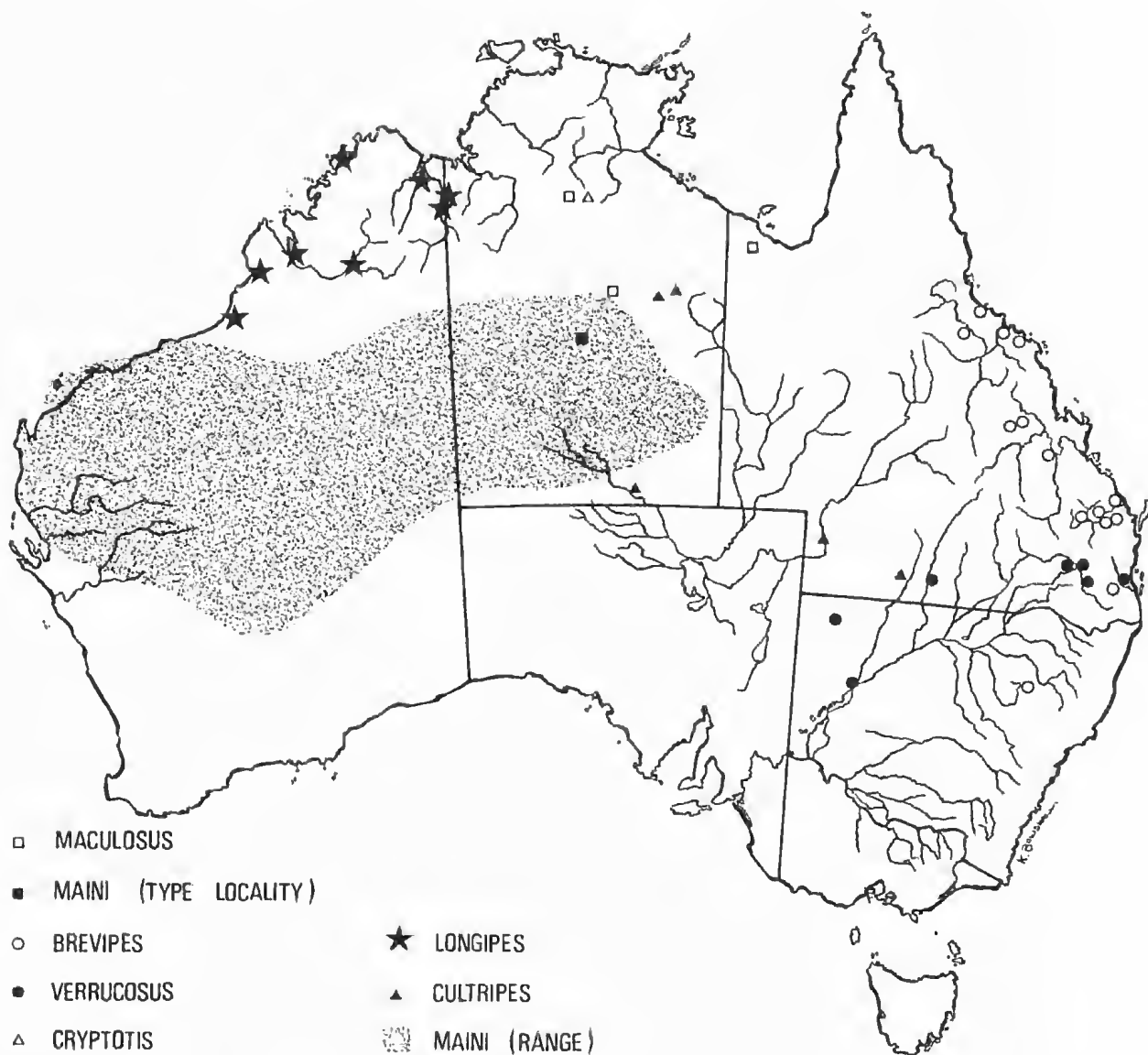


FIG. 4

Distribution of seven species of *Cyclorana*. The stippled area represents the geographic range of *C. maini*.

postocular bar and a narrow, pale vertebral stripe on an otherwise featureless dorsum (Fig. 5).

**Description:** The head is triangular and distinctly broader than long (HL/HW 0.88-0.97). The snout is rounded when viewed from above and in profile. The eye is inconspicuous but its diameter is greater than the eye to naris distance. The canthus rostralis is straight and inconspicuous. The nostrils are inclined laterally and are separated from one another by a distance which is greater than or less than the eye to naris distance (E-N/IN 0.89-1.31). The tympanum is entirely visible except for a portion of the superior margin of its annulus which is hidden beneath the supra-tympanic fold.

The tongue is broad and is almost entirely free behind. The choanae are small and widely spaced, and the vomerine teeth are on oblique converging elevations whose posterior margins just reach or extend posterior to the posterior margins of the choanae.

The fingers are short, unwebbed and lack lateral fringes. The foot has a prominent inner metatarsal tubercle (Fig. 1). The toes are only slightly webbed, the webbing on the fifth toe not reaching the subarticular tubercle at the base of the penultimate phalanx. The hind limbs are very short (TL/S-V 0.33-0.40).

The skin of the dorsal surface is smooth except for occasional tubercles on each side of the mid-line in a few specimens. Ventrally the skin is weakly granular in the posterior portion of the abdomen and smooth elsewhere.

In preservative the dorsum is a dull and uniform greyish or brownish colour. A pale postocular bar varies from being conspicuous to just detectable, whilst a very fine, white or creamish vertebral stripe can be seen quite clearly. The ventral surface is usually cream with the throat of males a dark grey. NMV D 12703 is entirely grey ventrally, but this may be an artefact of preservation.

**Material examined:** Northern Territory—BM 1908. 2.25.33 (Holotype), BM 1947. 2.18.46-47 (Paratypes), MCZ 11647, Alexandra; NMV D 5732 Charlotte Waters; NMV D 12703 "Central Australia" Spencer Collection; SAM R 14724-25 Alroy Downs; SAM R 14726 Barrow Creek, Western Australia—WAM R 27251 17 km N. of Argyle turn off on Duncan Highway. Queensland—NPWS 12610, 12622 Durham Downs; NPWS 12628-29, 12632-36 Dynevor Downs.

**Comparison with other species:** *Cyclorana cultripes* is set apart from most congeners by its rather drab appearance. The dull greyish or

brownish dorsum is relieved only by the pale postocular bar and the mid-vertebral stripe. Of the six other species reported here only *C. cryptotis* shares the absence of particularly conspicuous patches or mottling of the dorsal surface. The externally visible tympanum distinguishes *C. cultripes* from *C. cryptotis* which has the tympanum covered with skin and so not visible externally. *Cyclorana cultripes* lacks the dark lateral head stripe of *C. maini*.

**Call:** Calls of two specimens of *C. cultripes* were recorded at Alroy Downs, N.T., on 12.xii.1971. This locality is approximately 70 km W.S.W. of the type locality. The frogs were calling from the margins of a flooded roadside ditch; the wet bulb air temperature was 23.8°C. Means and ranges of call values are: duration 221 msec (220-223); dominant frequency 1879 Hz (1857-1900); pulse repetition rate 373 pulses/sec (370-375) (Fig. 3).

**Distribution:** As presently defined *C. cultripes* is known from five localities, all in or adjacent to the Northern Territory. The presence of the species as far south as Charlotte Waters indicates that it probably occurs in South Australia. However the specimen involved is part of the Spencer Collection. Thus the precision of the locality is questionable.

**Discussion:** Parker (1940) was the first to observe that a wide diversity of animals were being identified as *brevipes*. Accordingly he referred four of the specimens available to him to the new species *cultripes* which he erected to accommodate specimens from "Western New South Wales, Northern Territory and northern West Australia, probably northern South Australia also". Parker was certainly correct in recognising the existence of an additional species, but he included in his type series a female from Wilcannia on the Darling River, N.S.W. This individual we refer to the new species, *verrucosus*. Similarly Parker's deductions about the identity of specimens from other parts of Australia and not examined by him are attributable to other species described in the present paper.

#### *Cyclorana verrucosus* new species

*Phractops brevipalmatus* (non Gunther), Fry 1915: 70.

*Phractops brevipes* (non Peters). Loveridge, 1935: 12.

*Cyclorana cultripes* Parker, 1940: 22 (part).

**Holotype:** QM J 18105, a gravid female collected 18 km W. of Dalby, Queensland by I. R. Straughan on 8.ii.1964.

**Definition:** A moderate-sized species (males 35-45 mm; females 39-48 mm S-V) with a dull and diffusely marked dorsal colouration and a slightly to extremely warty dorsal skin surface.



FIG. 5  
*Cyclorana verrucosus*. Photo: A. Easton

**Description of Holotype:** The head is high, broadly triangular and distinctly broader than long (HL/HW 0.91). The snout is rounded when viewed from above and in profile. The eye is large and prominent, and its diameter is equivalent to one and one-third times the distance between the eye and the naris. The canthus rostralis is poorly defined and very slightly curved. The nostrils are inclined dorso-laterally and are separated from one another by a distance very slightly less than the internarial span (E-N/IN 1.03). The tympanum is visible except for a small superior portion of the annulus which passes beneath the supratympanic fold.

The tongue is very broad and is almost entirely free behind. The choanae are small and broadly spaced and the vomerine teeth are on oblique, converging elevations whose posterior margins are anterior to the posterior borders of the choanae.

The fingers are slender and unwebbed and lack lateral fringes. The foot has a prominent inner metatarsal tubercle and the toes are webbed only at the base. The webbing on the fifth toes does not reach the subarticular tubercle at the base of the penultimate phalanx. The hind limbs are short (TL/S-V 0.45).

The skin of the dorsal surface bears numerous, raised, circular, oval and elongated tubercles. There is a rather prominent supratympanic fold. The skin is finely granular on the lower thighs and abdomen and smooth on the pectoral and submandibular region.

The dorsal surface is a very pale olive colour with small darker patches conforming to the tubercles and intermediate zones of dark grey.

There is a narrow dark stripe from the tip of the snout to the eye, broadening as a dark postocular patch covering the tympanum and bordered superiorly and posteriorly by the supratympanic fold. There is an extremely narrow white vertebral stipe (Fig. 5). The posterior surfaces of the thighs are dark brown mottled with paler areas (Fig. 2). The ventral surface is dull cream with indistinct and sparse faint brown mottling on the submandibular area.

**Dimensions:** S-V 43.8 mm; TL 19.5 mm; HL 17.3 mm; HW 19.1 mm; E-N 3.6 mm; IN 3.5 mm; E 5.7 mm; T 3.5 mm.

**Paratypes:** There are 15 adult paratypes: *Queensland*—QM J 12274, Brookstead via Pittsworth, recd. I. R. Straughan 17.ii.64; QM J 18108, 18116 21 km E. of Dalby, coll. A. K. Lee and I. R. Straughan, 16.xi.63; QM J 18111 18 km W. of Dalby, coll. I. R. Straughan, 8.ii.64; QM J 18104, 18107 Waratah Stn. via Cunnamulla, coll. A. K. Lee; QM J 18109, 18112, 18114-15, 18117, Warrawee near Petrie, coll. I. R. Straughan, 7.xii.62-10.ii.64; *New South Wales*—BM 1947.2.18.48 (formerly 1911.3.28.1, and AM R 5149), Wilcannia, Darling River (Paratype of *C. cultripes*), MCZ 3585-86 (same locality), all coll. W. Stalker; SAM R 14081 Sturt Ntl. Pk. near Tibooburra, coll. R. Galt.

The male paratypes range in size from 37.3 to 45 mm and the females from 37.2 to 49.2 mm. Variations in body and limb proportions are presented in Table 1. The paratypes are fairly homogeneous and share a conspicuously roughened dorsal surface with diffuse markings. The dorsum varies from greyish to an obscure very dark brown; the posterior surfaces of the thighs are commonly a different shade of brown to the dorsum, and are usually irregularly flecked with pale grey. The vertebral stripe is a constant feature. The throats of the male paratypes are deeply suffused with uniform slate.

An additional four specimens probably represent *verrucosus*, but have been excluded from the paratype series, because of doubt about their conspecificity. Three are recently metamorphosed

TABLE 1  
SIZES AND PROPORTIONS OF SOME *CYCLORANA* SPECIES

Species	n	S-V ♂♂	S-V ♀♀	TL/S-V	E-N/IN	HL/HW
<i>brevipes</i>	21	36.4-45.8	33.0-38.3	0.36-0.45	0.97-1.19	0.84-0.98
<i>cryptotis</i>	1	40.8	—	0.42	1.13	0.81
<i>cultripes</i>	18	42.7-52.2	44.0-55.1	0.33-0.40	0.89-1.31	0.88-0.97
<i>longipes</i>	10	37.5-45.9	43.8-47.8	0.36-0.45	1.12-1.36	0.90-0.95
<i>maculatus</i>	6	47.4-49.5	48.8-50.6	0.31-0.38	0.95-1.14	0.90-0.95
<i>maui</i>	50	35.4-46.4	38.7-47.2	0.33-0.41	0.97-1.23	0.88-0.98
<i>verrucosus</i>	16	34.7-45.0	39.2-47.8	0.35-0.45	0.94-1.25	0.89-0.96

Measurements are in millimetres.



juveniles (QM J 18106, 18110, 18113) ranging from 18.4 to 22.4 mm S-V. There is also a transforming tadpole (QM J 18119). The series was taken at Waratah Station with two of the *verrucosus* paratypes.

*Comparison with other species:* For many years field workers in eastern Queensland have recognised the existence of two species. The first is *C. brevipes*, and the second has been erroneously referred to as *C. cultripes*. With clarification of the morphology of *C. cultripes*, the Queensland population can be distinguished quite readily by its tendency to exhibit verrucosities on the skin (*C. cultripes* is usually quite smooth), the extensive irregular mottling of the dorsum (see Fig. 2), and by a tendency for *verrucosus* to have longer hind limbs (Table 1).

Although *C. brevipes* and *C. verrucosus* both have extensive dorsal pigmentation, the dark markings of *C. brevipes* are sharply defined peripherally, whereas *C. verrucosus* is diffusely marked. Individuals of both species may be rough skinned, but the verrucosities in *C. verrucosus* are rendered conspicuous by being surrounded by areas of paler pigmentation. In *C. brevipes* there is no such highlighting and they are indistinct. In lateral view (Fig. 2) *C. verrucosus* has a higher head than *C. brevipes*. As in members of the *C. australis* group (Tyler & Martin 1975), we have been unable to express these differences in a quantitative fashion.

*Distribution:* *Cyclorana verrucosus* extends from south-eastern Queensland to north-western New South Wales. It is sympatric with *C. brevipes* over a limited portion of its range (Fig. 4).

#### *Cyclorana maculosus* new species

*Holotype:* SAM R 14719, an adult male collected at Daly Waters, Northern Territory by B. Low and D. F. Gartside on 13.xii.1971.

*Definition:* A moderate-sized species (males 47-49 mm, females 49-51 mm S-V) with short hind limbs and a pattern of markings in which there are strong contrasts of small dark patches on a lighter background (Fig. 6).

*Description of Holotype:* The head is rather flattened, triangular and distinctly broader than long (HL/HW 0.93). The snout is rounded when viewed from above and in profile. The eye is not prominent but its diameter is considerably greater than the eye to naris distance. The canthus rostralis is straight and distinguishable by the shelf-like structure of the maxilla. The nostrils are inclined superiorly and are separated from one another by a distance which is less than

the eye to naris distance (E-N/IN 1.13). The tympanum is entirely visible but for a portion of the superior margin of its annulus which is hidden beneath the supratympanic fold.

The tongue is broad and is almost entirely free behind. The choanae are widely spaced and the vomerine teeth are on oblique, converging elevations whose posterior margins are anterior to the posterior borders of the choanae.

The fingers are slender and unwebbed. The foot has a prominent inner metatarsal tubercle. The toes are slightly less than one-half webbed; the webbing on the fifth toe not reaching the subarticular tubercle at the base of the penultimate phalanx. The hind limbs are very short (TL/S-V 0.34).

Macroscopically the skin of the dorsal surface is quite smooth; under low-power magnification it can be seen to be covered by numerous, flattened tubercles. Ventrally the skin is weakly granular over the posterior half of the abdomen, and smooth anteriorly.

The dorsal surface is a uniform very pale grey on which there are a few clearly demarcated black markings. There is a stripe from the tip of the snout through each nostril to the eye. Behind the eye this stripe envelops the tympanum and continues to the insertion of the forearm, bordered superiorly by the supratympanic fold. There are a pair of small ellipsoid markings on the scapula and elongate markings on the flanks and in the groin. There is a narrow white vertebral stripe and a pale postocular bar. The posterior surface of the thighs is a uniform dull grey. The ventral surface of the body is cream with a dark slate submandibular region.

This adult male specimen has a submandibular vocal sac with short, paired openings near the mandibular articulation, and two distinctly separated, brown nuptial pads on each first digit.

*Dimensions:* S-V 47.4 mm; TL 16.2 mm; HL 16.9 mm; HW 18.1 mm; E-N 3.6 mm; IN 3.2 mm; E 5.4 mm; T 3.6 mm.

*Variation:* There are five paratypes—SAM R 14717-18, collected at the type locality with the holotype; SAM R 7612, Doomadgee Mission, Qld., G. Douglas, February, 1966; NTM 3178, Stuart Highway at Tennant Creek, D. Lindner, 30.i.66; SAM R 14736, Tennant Creek, J. F. Field, April, 1907.

The paratypes comprise two adult males (S-V 48.8-49.5 mm) and three adult females (48.8-50.6 mm). In all specimens the limbs are short (TL/S-V 0.31-0.38). Topotypic material varies only in the extent and distribution of dark markings and differs from the holotype in the presence

of a broad, pale postocular bar and a pale border on each side of the mid-vertebral stripe.

The lighter markings are most pronounced in the Doomadgee Mission specimen, whereas the paratypes from Tennant Creek vary from having minimal dark markings to extensive areas of dark pigment.

*Comparison with other species:* *Cyclorana maculosus* is a rather large species in comparison with the others described here. In fact each of

the three adult males is larger than all males of all other species included. However it is its striking dorsal colouration that sets *maculosus* apart from congeners. Namely the isolated, jet black, patches contrasting with a pale background. The species with which there is partial sympatry (*C. cultripes* and *C. maini*) lack black patches, although the latter shares with *maculosus* a conspicuous dark stripe on the side of the head.

*Call:* The call of the holotype was recorded at Daly Waters, N.T., on 13.xii.1971. The site was

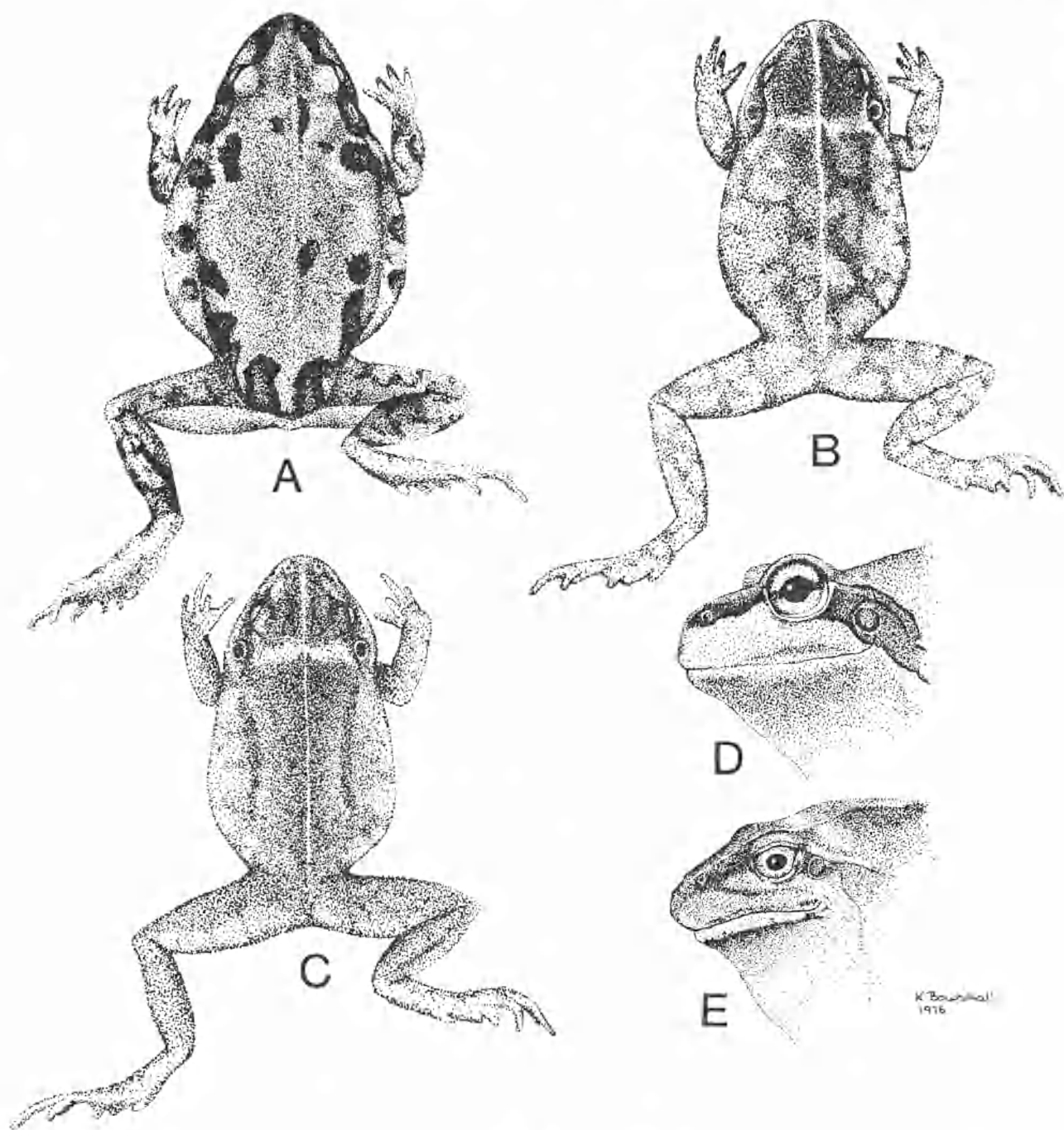


FIG. 6

Dorsal and lateral views of *Cyclorana* species. A = *C. maculosus* (SAM R 14717); B and C = *C. cultripes* (NMV D 12703, SAM R 14725); D = *C. maculosus* (SAM R 14717); E = *C. cultripes* (SAM R 14725).

a small roadside ditch; wet bulb air temperature was 24.1°C. Call values are: duration 1810 msec; dominant frequency 1767 Hz; pulse repetition rate 108 pulses/sec. (Fig. 3).

**Distribution:** The species is currently known from two localities on the Stuart Highway, N.T., and one in Queensland (Fig. 4).

*Cyclorana cryptotis* new species

**Holotype:** SAM R 14716, an adult male collected at Daly Waters, Northern Territory by B. Low and D. F. Gartside on 13.xii.1971.

**Definition:** A small species (male adult at 41 mm) which is also characterised by having the tympanum covered with skin (and hence invisible externally), and by its obscure greyish colouration (Fig. 7).

**Description of Holotype:** The head is rather flattened, broadly triangular and distinctly broader than long (HL/HW approximately 0.87). The snout is rounded when viewed from above and rather truncated in profile. The eye is not prominent but its diameter is greater than the eye to naris distance. The canthus rostralis is almost straight and very poorly defined. The nostrils are inclined superiorly and are separated from one another by a distance slightly less than the eye to naris distance. The tympanum is completely hidden beneath the skin.

The tongue is roughly circular, not large and almost entirely free behind. The choanae are widely spaced and the vomerine teeth are on elevations projecting slightly behind the posterior margin of the choanae.

The fingers are slender and unwebbed. The foot has a prominent inner metatarsal tubercle. The toes are approximately one-half webbed, the webbing on the fifth toe reaching the subarticular tubercle at the base of the penultimate phalanx. Hind limbs are of moderate size (TL/S-V 0.42).

The skin of the dorsal surface is covered with numerous and densely aggregated, flattened tubercles. Ventrally the skin is granular except in the pectoral region where it is almost smooth.

The dorsal surface is pale grey suffused with irregular darker markings. There is a narrow, disrupted, white vertebral stripe and broader, dark stripes between the nostril and eye and from the eye to the insertion of the forearm. The ventral surface of the body is cream with a greyish submandibular region. The plantar surface is lightly stippled with very dark brown. This adult male specimen has a submandibular vocal sac with short, paired openings near the mandibu-

lar articulation, and two distinctly separated, unpigmented nuptial pads on each first digit.

**Dimensions:** S-V 40.8 mm; TL 17.0 mm; HL 13.8 mm; HW 17.1 mm; E-N 3.4 mm; IN 3.0 mm; E 5.0 mm; T 2.2 mm.

**Comparison with other species:** *Cyclorana cryptotis* has few obvious affinities with other species. The lack of any dark markings on the dorsum is shared by *C. cultripes* and some individuals of *C. maini*. However *C. cryptotis* has the tympanum completely covered with skin, whereas it is visible externally in *C. maini* and all other members of the genus. A further feature unique to *C. cryptotis* is the rather compressed head producing the exceptionally low HL/HW ratio of 0.81 (0.84-0.99 are the limits of the ranges for all other species).

**Call:** The call of the holotype was recorded at Daly Waters, N.T., on 13.xii.1971. The frog was calling from the margin of a flooded ditch; wet bulb air temperature was 24.1°C. Call values are: duration 530 msec; dominant frequency 1060 Hz; pulse repetition rate 158 pulses/sec (Fig. 3).

**Distribution:** *Cyclorana cryptotis* is known solely from the type locality of Daly Waters, N.T., (Fig. 4).

*Cyclorana longipes* new species

*Chiroleptes brevipalmatus* (non Gunther), Fletcher, 1899: 678.

*Phractops brevipalmatus* (non Gunther), Fry, 1915: 200.

**Holotype:** WAM R 43258, an adult female collected at Mitchell Plateau (140° 52' S; 125° 50' W), Kimberley Division, Western Australia by L. A. Smith and R. E. Johnstone on 5.ii.1973.

**Definition:** A moderate-sized species (males 37.5-45.9 mm; females 35.8-47.8 mm) with a skin texture which varies from smooth to very coarsely granular, and a colouration of dark patches on a lighter background (Fig. 7). The nostrils are narrowly spaced (E-N/IN 1.12-1.36).

**Description of Holotype:** The head is high, triangular and almost as broad as long (HL/HW 0.91). The snout is triangular when viewed from above and evenly rounded in profile. The eye is small, its diameter equivalent to one and one-quarter times the distance between the eye and the naris. The canthus rostralis is distinct and very slightly curved. The nostrils are inclined dorso-laterally and are separated from one another by a distance which is less than the eye to naris distance.



(E-N/IN 1.25). The tympanum is almost entirely visible except for the upper portion of the tympanic annulus which passes beneath the supratympanic fold.

The tongue is very broad and almost entirely free behind. The choanae are small and broadly spaced and the vomerine teeth are on prominent, oblique, converging elevations whose posterior margins are posterior to the choanae.

The fingers are moderately long, slender, unwebbed and without lateral fringes (Fig. 1). The foot has a small but prominent inner metatarsal tubercle. The webbing between the toes is comparatively well developed, and on the medial surface of the fifth toe reaches the posterior edge of the subarticular tubercle at the base of the penultimate phalanx. The hind limbs are very short (TL/S-V 0.38).

Anteriorly the skin of the dorsal surface is very coarsely granular. There are distinct plicae

between the upper eyelids and in the form of a continuous dorsolateral glandular fold extending to the flanks. Posteriorly the skin becomes progressively less conspicuously granular, the individual granules being smaller and less prominent. The ventral skin is finely granular from the posterior surface of the thighs to the post-axillary pectoral skin fold. Anterior to that fold the skin is smooth. There is a small postmandibular gland.

The dorsal surface is a dull brown colour which is to a great extent covered by large, elongate, irregular patches of darker brown. The arrangement is disrupted on a level with the tympanum. There is a dark and clearly defined stripe from the tip of the snout through the nostril and eye to the tympanum. There is also a pale vertebral stripe which is quite broad above the sacral region and tapers to a very narrow line at the snout and cloaca. The posterior surfaces of the thighs are spotted with pale grey on a dark brown back-

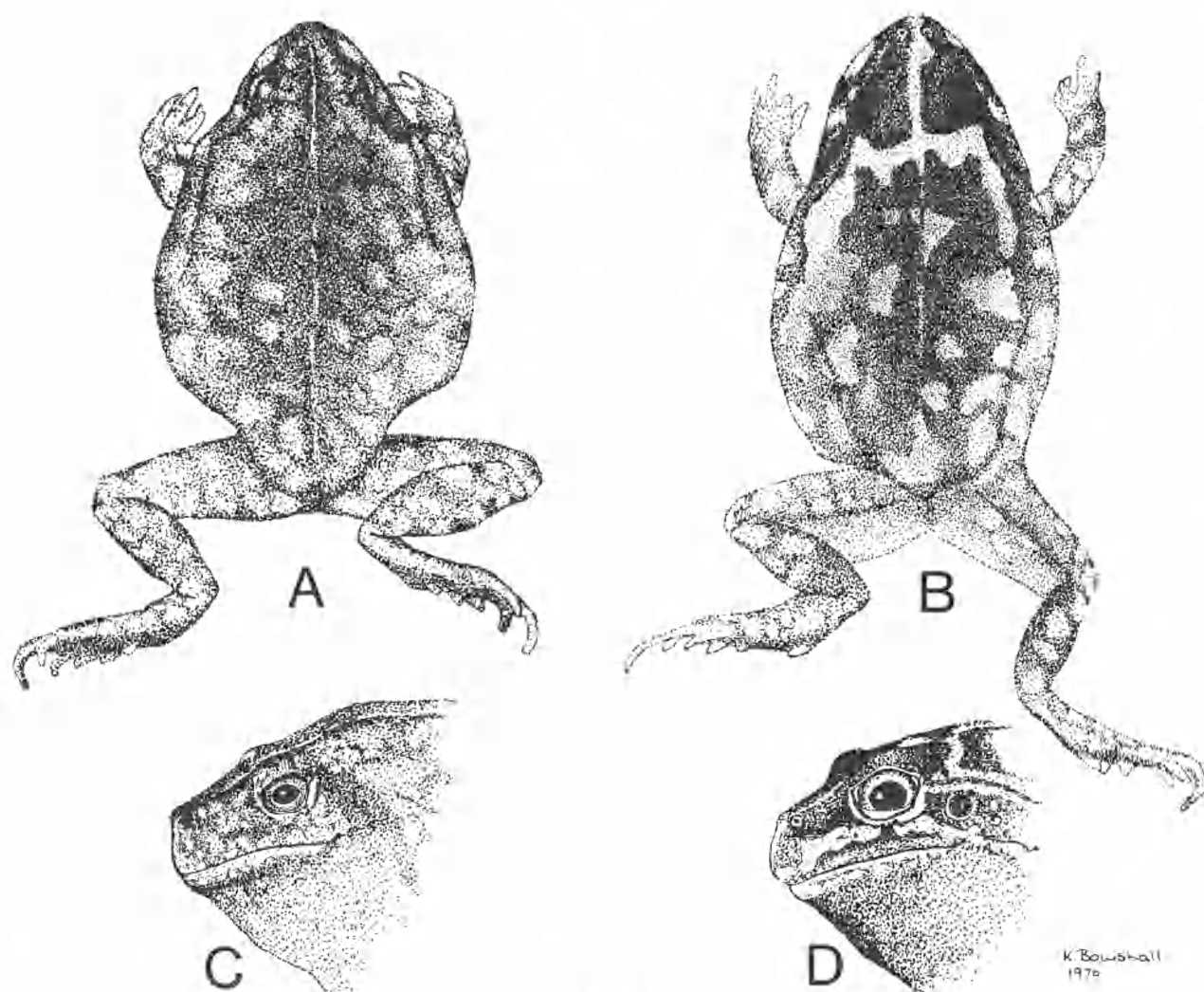


FIG. 7

Dorsal and lateral views of *Cyclarana* species. A and C = *C. cryptotis* (SAM R 14716); B and D = *C. longipes* (WAM R 14157).



ground, and there is similar spotting in the groin. The ventral surface of the body and limbs is a dull cream.

**Dimensions:** S-V 47.8 mm; TL 18 mm; HL 16.3 mm; HW 18 mm; E-N 4 mm; IN 3.2 mm; E 5 mm; T 3.1 mm.

**Variation:** There are 43 paratypes, comprising nine adults and 34 juveniles, all from localities in Western Australia: WAM R 14157, Broome, K. Male, 14.ii.1962; WAM R 43199-43200, L. A. Smith & R. E. Johnstone 5.ii.73, R 43268-75, Smith & Johnstone 21.ii.73, R 43294-95, R 43346 Smith & Johnstone 22.ii.73, all from Mitchell Plateau; WAM R 32349-51, Wyndham, T. Nelson 19.iv.68; WAM R 44735-59 Lake Argyle, Smith & Johnstone, 5.i.72; WAM R 42388, Mt. Phire, W. H. Butler 29.ix.63.

None of the female adult paratypes is as large as the holotype female, their size being 35.8-43.8 mm. Males have an S-V length range of 37.5-45.9 mm, and there is a female 40.3 mm long. The subadult material ranges in S-V length from 21.8 to 33.2 mm.

Variations in adult dimensions are shown in Table 1; the consistently high E-N/IN ratio (1.12-1.36) is notable.

Colouration of adults and juveniles is rather variable. In the figured specimen from Broome the darker markings are particularly extensive, because the longitudinally arranged markings have partly coalesced. In many juveniles and adults from the Mitchell Plateau the longitudinal orientation is detectable, but the markings are broken up into separate segments. The featureless post-orbital area, the presence of a mid-vertebral stripe and the spotted pattern of light markings on the posterior surface of the thighs are the only features common to all individuals.

Males have a submandibular, unilobular vocal sac and the submandibular area of the largest male (WAM R 14157) is almost black.

**Comparison with other species:** All individuals of *C. longipes* exhibit a dorsal pattern in which there are black markings on a contrasting light background. The only other species sharing such a feature are *C. maculosus* and *C. brevipes*. *Cyclorana maculosus* tends to be a shorter-limbed frog (TL/S-V 0.31-0.38 as opposed to 0.36-0.45 in *C. longipes*). Similarly *C. maculosus* has a lower E-N/IN ratio range of 0.95-1.14, compared with 1.12-1.36. Other data in Table 1 indicate that *C. longipes* may be a slightly smaller species. However, existing samples of adults of each species are inadequate to confirm the apparent trend.

**Distribution:** Fletcher (1898) reported *Cyclorana brevipes* (as *Chiroleptes brevipalmatus*) from two localities in northern Western Australia (Kings Sound and the junction of Margaret Creek with the Fitzroy River). Parker (1940) attributes the records to *C. cultripes*. However the situation of these localities within the range of *longipes*, and the striking similarity of *longipes* to *brevipes*, cause us to favour the new identification. Thus *C. longipes* is now known to occupy the coastal zone of northern W.A. and to penetrate inland via the Fitzroy River. At its southern boundary the arid Eighty Mile Desert effectively isolates the species from *C. maini*. However there is no such geographic barrier to dispersal in the west, and *longipes* may extend into the Northern Territory and be sympatric with at least one other species reported here.

#### *Cyclorana maini* new species

*Chiroleptes brevipalmatus* (non Gunther), Spencer (1896): 165.

*Cyclorana* sp., Warburg (1967): 27, (1972): 91.

*Cyclorana cultripes* (non Parker), Cogger (1975) pl. 214.

**Holotype:** SAM R 15191. An adult male collected at Barrow Creek, Northern Territory by D. F. Gartside and B. Low on 11.xii.1971.

**Definition:** A moderate-sized species (males 35.4-46.4 mm; females 38.7-47.2 mm) characterised by a dark lateral head stripe and irregular darker patches on a pale dorsum in most specimens (Fig. 8).

**Description of Holotype:** The head is high, distinctly broader than long, evenly rounded when viewed from above and projecting slightly downwards in profile (HL/HW 0.93). The eye is large and prominent, and its diameter is equivalent to one and one-half times the diameter of the distance between the eye and the naris. The canthus rostralis is straight and quite prominent. The nostrils are inclined dorsolaterally and are separated from one another by a distance very slightly greater than the internarial span (E-N/IN 1.03). The tympanum is visible and is not overlapped by the supratympanic fold.

The tongue is very broad and slightly free behind. The choanae are obliquely inclined and are separated in the midline, and the vomerine teeth are on converging, oblique elevations whose posterior margins are posterior to the choanae.

The fingers are slender, unwebbed and without lateral fringes, and have prominent subarticular tubercles. The foot has a prominent inner

metatarsal tubercle and the toes are long and webbed only at the base. The webbing on the fifth toe extends slightly above the base of the penultimate phalanx. The hind limbs are very short (TL/S-V 0.36).

The skin of the dorsal surface is very slightly pitted and raised tubercles on other areas are totally lacking. The supratympanic fold is weak and the skin of the ventral surface is almost entirely smooth. The posterior surfaces of the thighs are weakly granular.

The dorsal surface is a dull brown on which areas of darker pigment are densely scattered. A fine white vertebral stripe is present, and a dark stripe extends between the nostril and the eye,

and then divides at the axillary region and is covered posteriorly by isolated patches of dark pigment on the flanks.

The submandibular region is an intense dark grey, and the remainder of the ventral surface is dull creamish.

This male specimen has paired nuptial pads on the first finger and a submandibular vocal sac.

*Dimensions:* S-V 46 mm; TL 16.8 mm; HL 16.3 mm; HW 17.6 mm; E-N 3.6 mm; IN 3.5 mm; E 5.2 mm; T 3.3 mm.

*Variation:* There are 95 paratypes—*Northern Territory*—NTM 2309-11, 2316, Arid Zone Research Institute 5 km S of Alice Springs

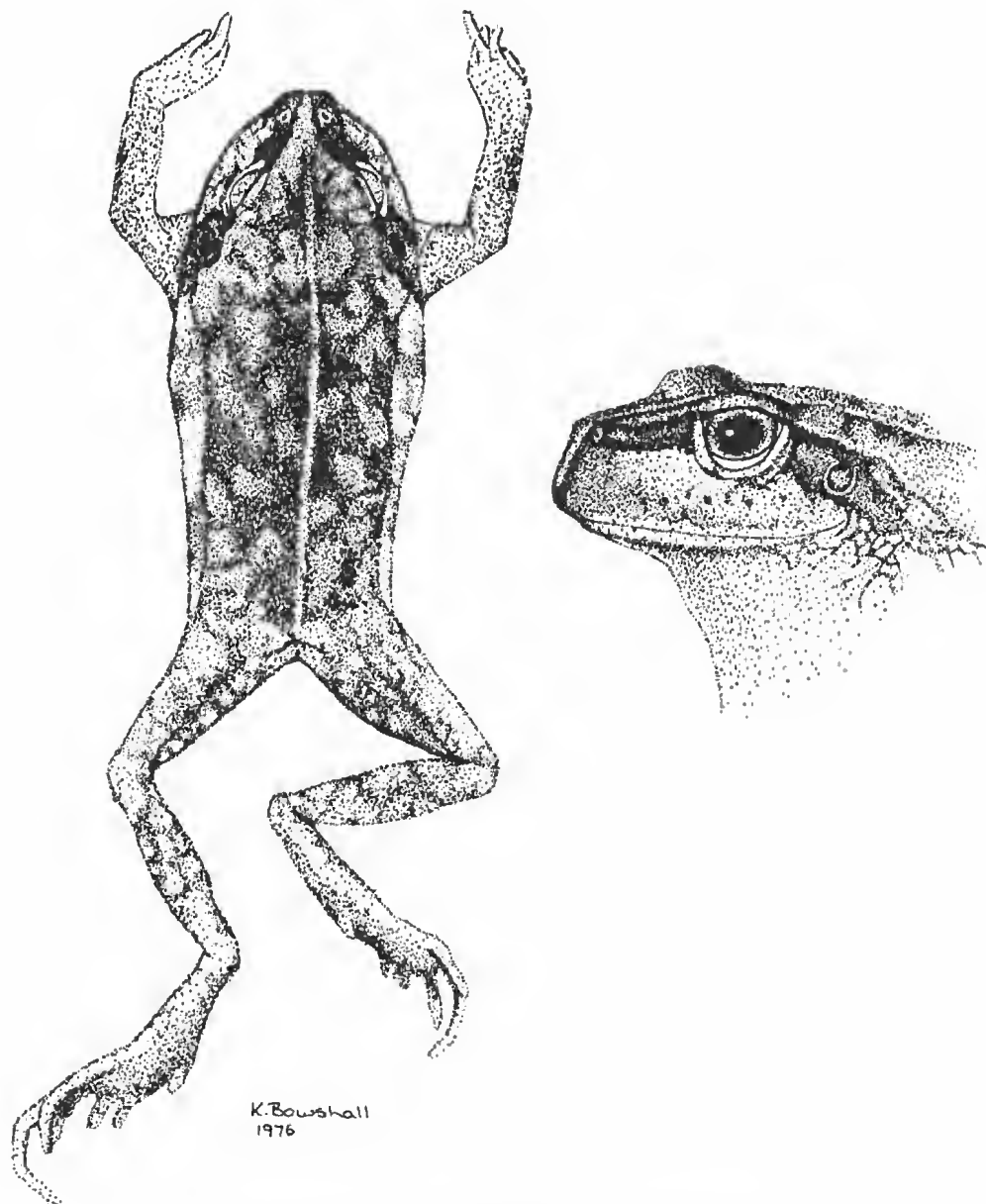


FIG. 8  
Dorsal and lateral views of *Cyclorana maini* (NTM 2311).

21.x.64; SAM 15192 10 km S of Alice Springs 3.xi.63; SAM 6311, 14715 27 km S of Alice Springs; NTM 3177 Mt. Doreen Stn., D. Lindner 23.i.66; SAM R 13038 A-D, Toko Range, S. Parker 20.i.72; *Western Australia*—SAM R 1711 Well No. 26, Canning Stock Route Expedition; WAM R 1440 Laverton, P. C. Warren, 1925 (accessed); WAM R 1510-11 Booylgoo Stn., E. L. Michel, 1925 (accessed); WAM R 10216 Mundabullangana, D. Lukis, 1951 (accessed); WAM R 10634 Roeburne, T. Stove, 1952 (accessed); WAM R 20546 Nannine, P. J. Fuller, 2.iii.63; WAM R 28486-508, SAM R 5979, R 15341-46 Mt. Edgar, A. R. Main & G. M. Storr, February, 1961; WAM R 28517, R 28536 Jiggalong, 6.xii.1959, presumably E. Lindgren; WAM R 28634-35, R 28638-48, R 39193-94 Mundabullangana, G. M. Storr, February, 1961; WAM R 28795 New Yamarna, 29.i.1967, WAM expedition; 28806-07 44 km SE of Leonora, WAM expedition; WAM R 28984-85, R 28987 8 km S of Mundabullangana, R. M. Sadler, 26.v.1960; WAM R 29127-28 Roeburne, Christchurch Grammar School, 22.v.67; WAM R 31444 presumably near Exmouth, D. G. Bathgate 1965-68; WAM R 32373-80, R 32382 Koordarrrie, N.T., Allen, 1967; WAM R 33188, Woodstock, E. H. M. Ealey 18.i.56; WAM R 33212, R 34791, R 34793 Woodstock, E. H. M. Ealey, February, 1957; WAM R 34206-07 Wittenoom, E. P. Hodgkin, 2.iii.1954; WAM R 34208 S of Wanning, E. H. M. Ealey, June, 1954; WAM R 36092 40 km N of Carnarvon, R. Humphries *et al.*, 4.ii.1970; WAM R 36094-96 near Winning, R. Humphries *et al.*, 4.ii.1970; WAM R 36105-06 Barrabiddy Creek, R. Humphries *et al.*, 5.ii.1970; WAM R 36695 Mandijarra R. H., NE of Carnegie, P. J. Fuller, 11.v.1970; WAM R 37248 Angel Is., Dampier Archipel., W. K. Youngson & P. Prince, 18.vi.1970; WAM R 39147 Talawana, J. B. Wade, 3.ii.1971; WAM R 40355 Durba Hills, W. H. Butler, early August, 1971; WAM R 45665-67, Bamboo Creek, A. M. & M. J. Douglas, 22.i.1974.

Because of the wide geographic area occupied by *C. maini* (Fig. 4), and because of limited data, particularly biological information, we are unable to give a definitive account of variation in this species. We can demonstrate that none of the individuals within this area represent *C. cultripes*, the species to which they have been referred in the literature; but we cannot assert that they all represent *C. maini*.

We have therefore omitted from our list of *C. maini* paratypes a number of individuals from Western Australia and the Northern Territory. Many are immature and others are so poorly

fixed or preserved that positive identification is not possible. Others again are satisfactorily preserved but possess sufficient morphological divergence from our concept of *C. maini* to warrant their exclusion. Individuals from the Peterman Ranges and adjacent localities in southeastern N.T. and Western Australia fall into this latter category. We are not able to make specific identification of this material, but suspect that they represent an additional species remaining undescribed. Ranges of measurements of *C. maini* appear in Table 1.

*Colour in life:* Specimens from Jay Creek 20 km W of Alice Springs have an extremely variable colouration. Individuals can change from green to brown in a matter of a few hours. Invariably the pattern consists of dark and commonly longitudinally orientated markings on a paler background. In all specimens a dark cantho-rostral stripe continues behind the eye to the flanks.

*Comparison with other species:* *Cyclorana maini* as defined here is readily distinguishable from congeners. Possession of a tympanum distinguishes it from *C. cryptotis*, and the limbs of the latter species may be slightly longer (TL/S-V 0.33-0.41 in 50 *maini*; 0.42 in the single *cryptotis*). The nature of the dorsal pattern of markings in *C. brevipes*, *C. longipes* and *C. maculosus* (clearly demarcated islands of dark pigment on a pale background), distinguishes each from *maini* which has obscure longitudinal streaks. The allopatric *C. verrucosus* has a dorsal skin with raised folds or large tubercles highlighted by being surrounded by dark pigment. *Cyclorana cultripes* tends to be a larger frog lacking the dark lateral head stripe and distinguished, as are most other species, by differences in mating call parameters (Fig. 3).

*Distribution:* Extending from the Hamersley Ranges in Western Australia in a continuous broad arc throughout central and southern Northern Territory to the western border of Queensland (Fig. 4).

*Habitat:* Main & Storr (1966) state that this species occurs "in small temporary watercourses with sandy or gravelly beds", and occasionally in larger wooded creeks and at windmills. It is found in areas that form swamps in wet weather but are dry at other times, and specimens have been dug from depths of 25 to 35 cm (Main 1965). It is clear from our examination of several sites at which this species has been taken that it can occur in flat, open, arid country subject to seasonal flooding.

*Call:* Calls attributed to this species (reported as *C. cultripes*) are as follows. Main & Calaby (1957) describe the call in the Pilbara region as



resembling a sheep bleating. Main (1965) considered it a "high pitched even maa-a-a-a". Main & Storr (1966) state that it is "loud, moderately high-pitched and rasping. Close up and in chorus, when the vibrato is clearly audible, the call sounds like an ambulance siren. At a distance it is more like the bleating of a sheep". Calls of two specimens were recorded at Barrow Creek, N.T., on 11.xii.1971. The frogs were calling at the edge of a pool in a sandy river bed; wet bulb air temperature was 22.6°C. Call values (mean and range) are: duration 814 msec (775-852); dominant frequency 1922 Hz (1867-1977); pulse repetition rate 244 pulses/sec (232-255) (Fig. 3).

**Biology:** Main & Calaby (1957) state that eggs are approximately 1.2 mm in diameter. Main (1965) reports the tadpoles to be comparable to those of *C. platycephalus* and that in their later stages they are pink with an opalescent sheen.

Details of the diet of 12 adult frogs are provided by Main & Calaby (1957) and of a further three by Calaby (1960). Termites and ants predominated in the diet of those individuals, but a small centipede was included.

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